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NATURAL FREQUENCY ESTIMATION FOR UNSYMMETRIC CROSS SECTION OF A TYPICAL CYLINDRICAL SHELL

A BARA I[1], BABITHA KODAVANLA[2], NILOUFER[3], E. RUTH[4] &

M. SATYANARAYANA GUPTA[5]

[1,2,3,4]*Institute of Aeronautical Engineering, Hyderabad, Telangana, India*

[5]*Marri Laxman Reddy Institute of Technology, Hyderabad, Telangana, India*

ABSTRACT

It's the trend of studying of complex geometries in the phenomenon of the aeronautical domain. Studying of unsymmetrical cross section of a cylindrical shell involves with the complex analysis than beams and plates. The usage of complex geometrical components involves in the design of aircraft fuselage, space shuttles, submarines and construction buildings. To maintain the safety of the components the vibration analysis carried out for the models to know their natural frequencies in avoiding resonance. In order to determine the natural frequency of the cylindrical shell, an analytical procedure is discussed. The modal is built in solid works and the modal analysis is carried out using ANSYS. The natural frequencies determined for various thickness and percentage of box cross section using tuning techniques then plotted in MATLAB.

KEYWORDS: ANSYS, MATLAB & Frequencies

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Original Article

INTRODUCTION

The recent advancements in the development of material structures and shapes for the better performance of the vehicles, as the design criteria which is a crucial phenomenon in the effective and improved structural performance of the vehicles so it is important to know about the characteristics of the designed material on applying the finite element analysis. Knowing the dynamic behavior of the material is of so important to predict the excessive deformations and internal stresses hence to find the modal analysis to know its natural frequency is very importance in reducing its resonance of the material. The experimental study of structural dynamics has always provided a major contribution to our efforts to understand and to control the many Vibration phenomena. Structural vibration problems continue to present a major hazard and design limitation for a very wide range of engineering products today. An energy method has been used by Rayleigh in the theory of in extensional vibration of cylindrical shells. Shells can freely vibrate in three directions.

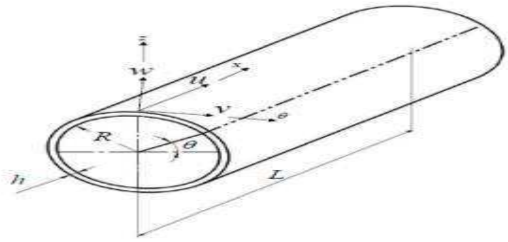


Figure 1: The cylindrical shell under consideration is with constant thickness h, mean radius R, axial length L, Poisson's ratio υ, density ρ and Young's modulus of elasticity E

Tuning Technics

Modal Assurance Criterion is one of the tuning techniques to find out the mode shapes. Modular Assurance Criterion (MAC) the Modal Assurance Criterion Analysis (MAC) investigation is utilized to decide the similar properties of two mode shapes. In the event that the mode shapes are indistinguishable the MAC will have an estimation of one or 100%. If the mode shapes are altogether different, the MAC esteem will be near zero. On the off chance that a mode shape was contrasted with itself, the Modal Assurance Criterion esteem ought to be one or 100%. For modes with various shapes, the MAC is under 1. Shapes that are altogether different will have an esteem near zero.

A Modal Assurance Criterion (or MAC) examination can be utilized as a part of a few distinctive ways: FEA-Test examination A MAC can be utilized to look at modes from a trial modular investigation test to a Finite Element Analysis (FEA). It will show if a similar mode shapes are found in both the test and FEA examination. FEA-FEA examination a few presumptions can be made in the formation of a FEA investigation: Young's Modulus, limit conditions, and mass thickness esteems to give some examples. A MAC examination can decide how much these presumptions influence the subsequent mode shapes. Test-Test examination A MAC investigation can hail potential issues with the modular investigation comes about. Generally MAC will recognize modes and territories that could profit by gaining more information focuses on the structure. A Modal Assurance Criterion (or MAC) investigation can be utilized for FEA-Test, FEA-FEA and Test examinations of modes. By breaking down a MAC framework, a designer can enhance the nature of a trial modular test, check limited component models, and refresh FEA models with test information.

METHODOLOGY

Cylinder Shell and External Features with Thickness 2.5mm

The cylindrical shell is design in solid works and then further modal analysis is done in workbench in order to determine the natural frequencies and mode shapes. This is done for cylindrical shell with external features which are attached to the cylindrical shell at various angle. The size of the external features keeps on decreasing in order to measure the difference in the natural frequencies which is further compared and plotted in MATLAB. A cylindrical shell of given specifications is design Length 5000mm Thickness: 2.5mm

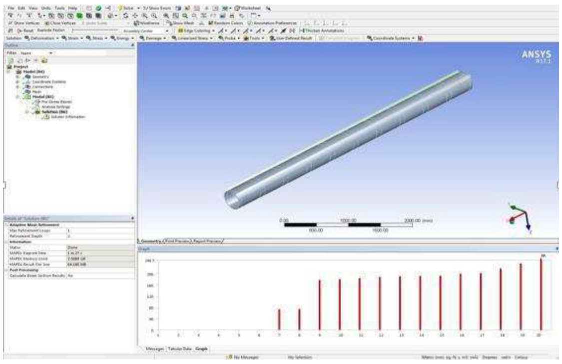


Figure 2: Construction of a Cylinder Shell with Thickness 2.5mm and Diameter 350mm

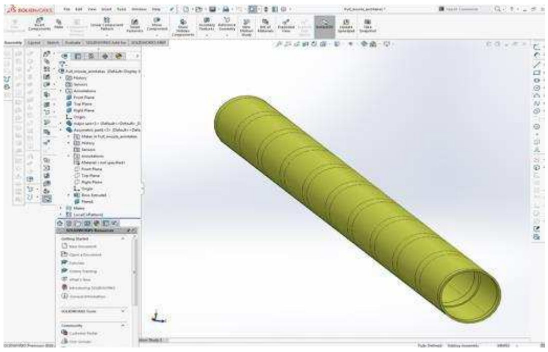


Figure 3: Natural frequency Graph and Values External Feature 100%

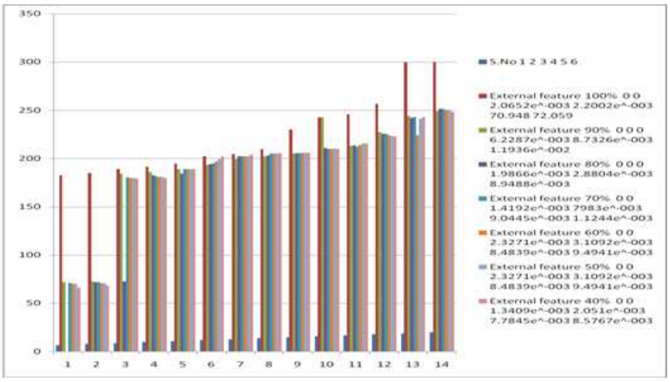


Figure 4: External feature for 40%, 50%, 60%, 70%, 80%, 90% and 100% for 2.5 mm

Design of Cylinder Shell with Thickness 2mm

The cylindrical shell is design in solid works and then further modal analysis is done in workbench in order to determine the natural frequencies and mode shapes. This is done for cylindrical shell with external features which are attached to the cylindrical shell at various angle. The size of the external features keeps on decreasing in order to measure the difference in the natural frequencies which is further compared and plotted in MATLAB. A cylindrical shell of given specifications is designed with length 5000mm and thickness 2mm.

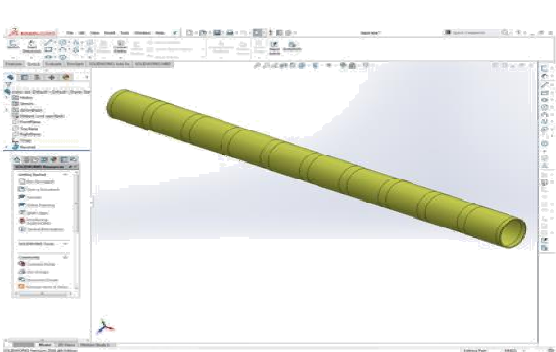


Figure 5: Solid Work Cylinder with 2mm Thickness

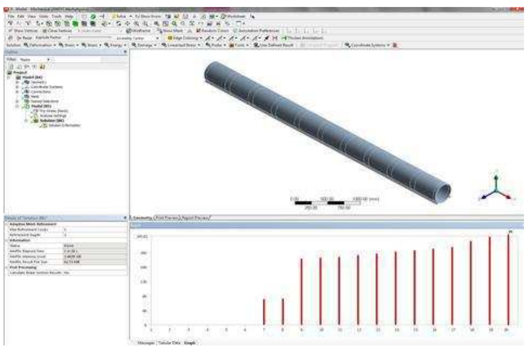


Figure 6: Natural Frequency Values and External Feature with 100% Thicknes

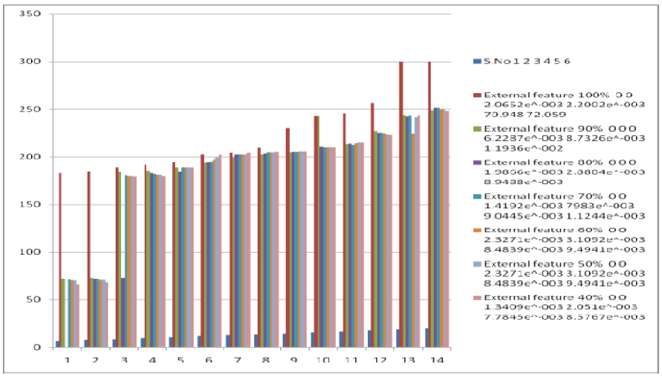
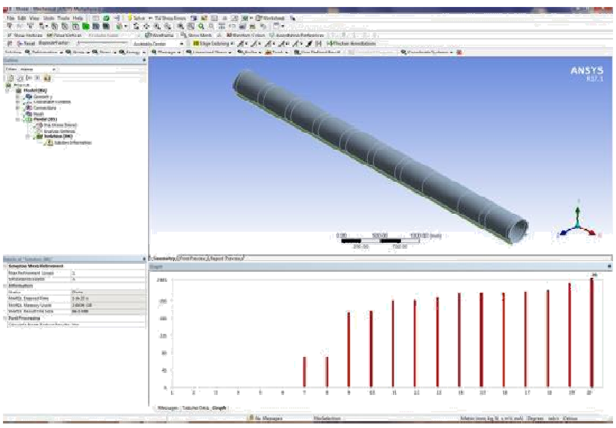


Figure 7: External Feature for 40%, 50%, 60%, 70%, 80%, 90% and 100% for 2 mm Thickness

Design of Cylinder Shell with Thickness 1.5mm

The cylindrical shell is design in solid works and then further modal analysis is done in workbench in order to determine the natural frequencies and mode shapes. This is done for cylindrical shell with external features which are attached to the cylindrical shell at various angles. The size of the external features keeps on decreasing in order to measure the difference in the natural frequencies which is further compared and plotted in MATLAB. A cylindrical shell of given specifications is drawn with Length 5000mm and Thickness 1.5mm.



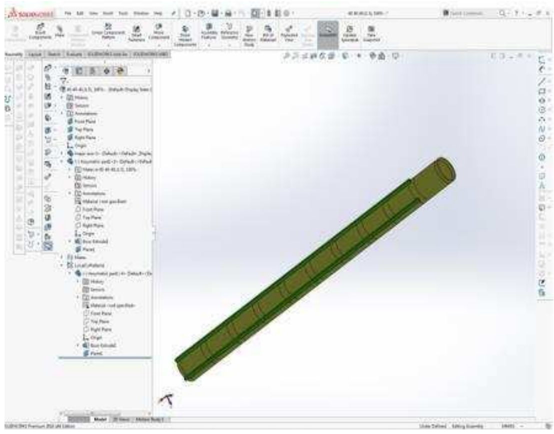


Figure 8: Design in Solid Works with External feature 90%

Figure 9: Natural frequency Graph with External Feature 100%

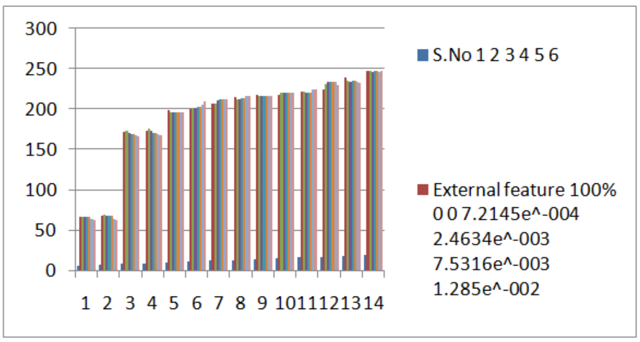


Figure 10: External Feature for 40%, 50%, 60%, 70%, 80%, 90% and 100% for 2.5 mm Thickness

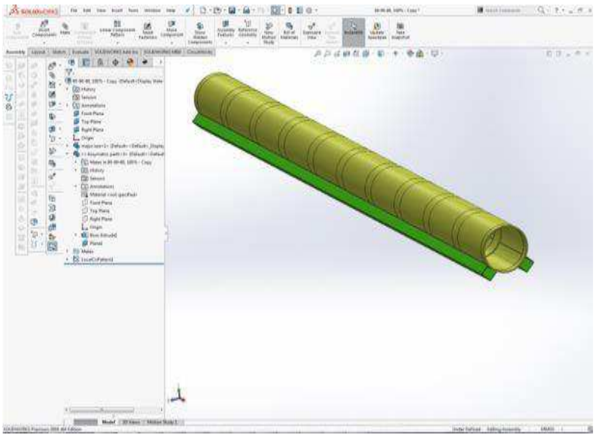


Figure 11: Cylinder Shell with Thickness 2mm and External feature with 80-90-80

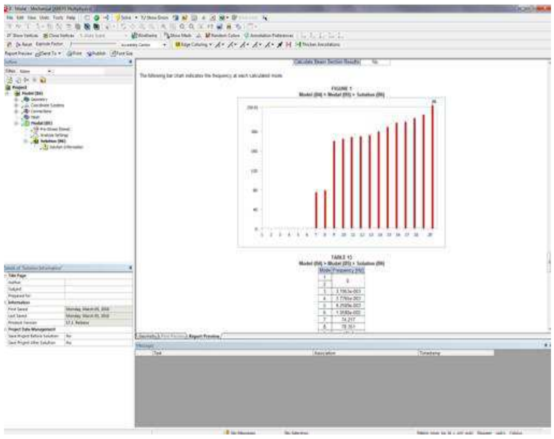


Figure 12: Design of Solid Work of a Cylinder Shell External Feature with 80-90-80 with 100%

Natural Frequency Graph with External Feature 100%

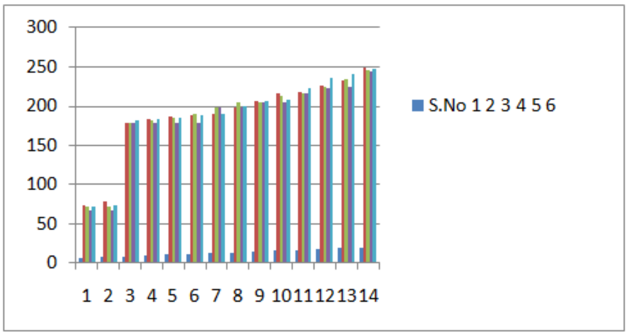


Figure 13: 80-90-80 with 100, 60, 40 with 2mm Thickness

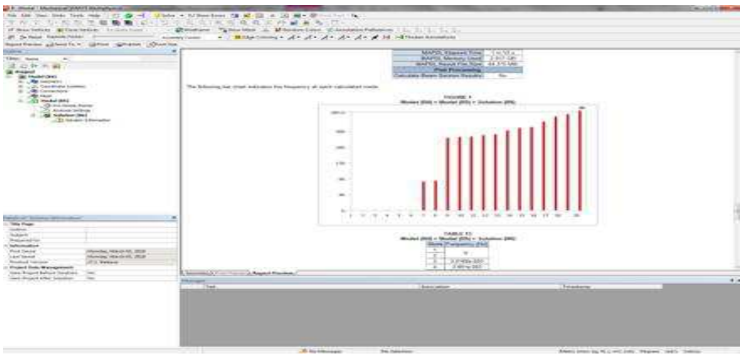


Figure 14: Natural Frequency Graph with External Frequency100%

Natural Frequency values of External Feature 60-70-60 with 100,60,40% and 2mm

Natural Frequency(HZ) VS External Feature with thickness 1.5mm, 2mm, 2.5mm

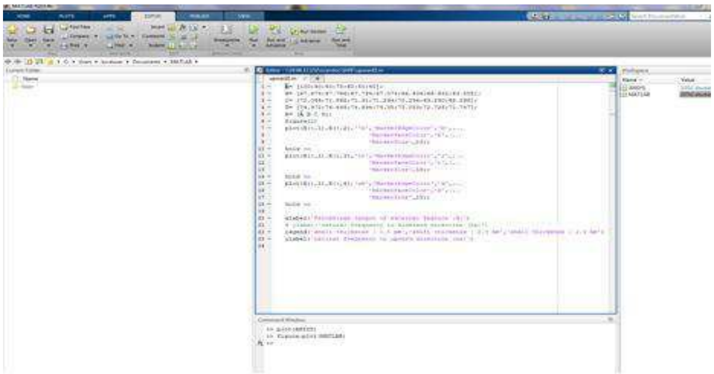


Figure 15: Upward Deformation

Natural Frequency (HZ) VS External Feature with thickness 1.5mm, 2mm 2.5mm

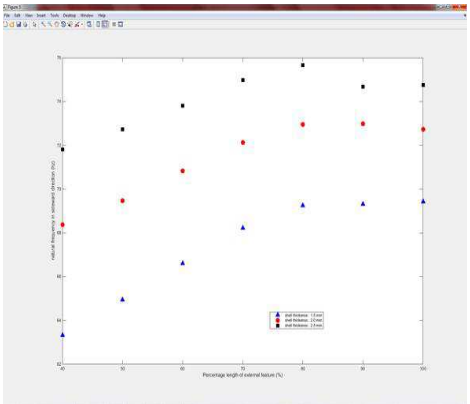


Figure 16: Upward Deformation Graph

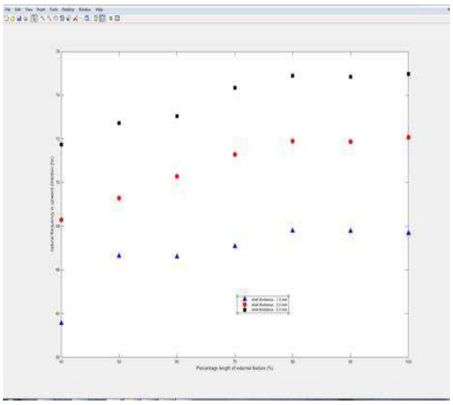


Figure 17: Sideward Deformation

MATERIAL PROPERTIES OF MILD STEEL

Material Properties of Steel in Solid Works

Table 1: Cylinder Shell Thickness 2.5(mm) with Different % of External Features

S. No	External Feature in (%)	Mass	Xcg
1	100%	210.83kg	2.52m
2	90%	208.98kg	2.54m
3	80%	207.13kg	2.56m
4	70%	205.27kg	2.57m
5	60%	203.42kg	2.58m
6	50%	201.57kg	2.58m
7	40%	199.72kg	2.58m

Table 2: Cylinder Shell Thickness 2(mm) with Different % of External Features

S. No	External Feature%	Mass	Xcg
1	100%	173.95kg	2.50m
2	90%	172.09kg	2.52m
3	80%	170.24kg	2.54m
4	70%	168.39kg	2.56m
5	60%	166.54kg	2.57m

Table 2: Contd.,

6	50%	164.54kg	2.57m
7	40%	162.28kg	2.57m

Table 3: Cylinder Shell Thickness 1.5(mm) with Different % of External Features

S. No	External Feature %	Mass	Xcg
1	100%	156.53kg	2.50m
2	90%	154.68kg	2.53m
3	80%	152.82kg	2.55m
4	70%	150.97kg	2.56m
5	60%	149.12kg	2.58m
6	50%	147.27kg	2.58m
7	40%	145.04kg	2.58m

Material Properties of Steel in Ansys

Table 4: Cylinder Shell Thickness 2.5(mm) with Different %of External Features

S. No	External Feature %	Mass in Ansys
1	100%	206.88kg
2	90%	205.06kg
3	80%	203.24kg
4	70%	201.42kg
5	60%	199.61kg
6	50%	197.79kg
7	40%	195.97kg

Table 5: Cylinder Shell Thickness 2(mm) with Different % of External Features

S. No	External Feature %	Mass in Ansys
1	100%	170.86kg
2	90%	168.87kg
3	80%	167.05kg
4	70%	165.23kg
5	60%	163.41kg
6	50%	161.06kg
7	40%	159.78kg

Mat Lab Plotting

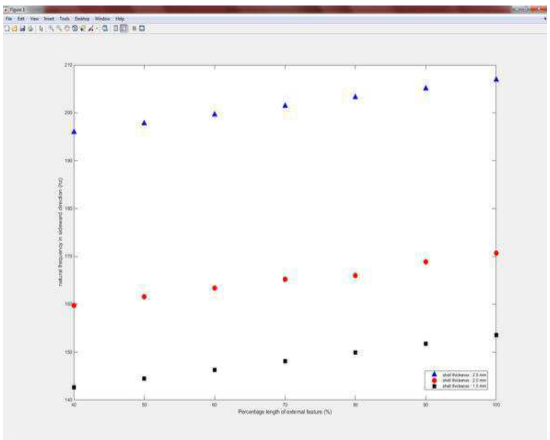


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Figure 18: Mass vs External Feature **Figure 19:Mass vs External Feature**

Table 6: Cylinder Shell Thickness 2.5mm, 2mm, 1.5mm and External Features 80-90-80

S. No	External Feature %	Mass	Xcg
1	100%	194.70kg	2.60m
2	60%	178.89kg	2.63m
3	40%	171.13kg	2.64m

Table 7: Cylinder Shell Thickness 2.5mm, 2mm, 1.5mm and External Features 60-70-60

S. No	External Feature in %	Mass	Xcg
1	100%	185.12kg	2.50m
2	60%	173.24kg	2.50m
3	40%	167.30kg	2.61m

Table 8: Cylinder Shell Thickness 2.5mm, 2mm, 1.5mm and External Features 80-90-80 in Ansys

S. No	External Feature %	Mass in Ansys
1	100%	191.05kg
2	60%	178.99kg
3	40%	167.92kg

Table 9: Cylinder Shell Thickness 2.5mm, 2mm, 1.5mm and External Features 60-70-60 in Ansys

S.No	External Feature	Mass in Ansys
1	100%	181.65kg
2	60%	169.99kg
3	40%	164.16kg

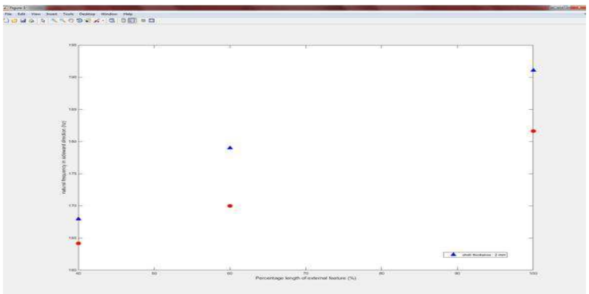

Figure 20: Mass vs External Feature

Table 10: Cylinder Shell Thickness 2.5(mm) and External Features 40-40-40 in Ansys

S.No	External Feature %	Mass(kg)In Solid Works	Xcg(m)	Mass(kg) in Ansys
1	100%	173.95kg	2.50m	170.68kg
2	60%	166.54kg	2.52m	163.41kg
3	40%	162.28kg	2.57m	159.78kg

CONCLUSIONS

The asymmetric structure characteristics such as natural frequency and mode shapes are estimated for variation of the following parameters.

- shell thickness
- length of the external feature
- cross section of the external feature

Various simulation are carried out and characteristics are estimated and comparative plots are generated to understand their implication. It can be clearly estimated that the shell at thickness 2mm at 100% external feature gives the best results comparatively 1.5mm and 2.5 mm. Hence results are compared and validated.

REFERENCES

1. *N Santhisree, M Prashanthkumar, "Thermal Analysis of a shell and tube heat exchanger", International Journal of Mechanical Engineering and Technology (IJMET) volume 8, Issue 5, May 2017.*
2. *Pinnamaneni Dileep Kumar, Anil Kumar, "Flow Analysis Experiment Around A Circular Cylinder with Splitter Plate", ", International Journal of Mechanical Engineering and Technology (IJMET) volume 7, Issue 5, Oct 2017.*
3. *Friswell, Michael, and John E. Mottershead. Finite element model updating in structural dynamics. Vol. 38. Springer Science & Business Media, 1995.*
4. *Bacon, Merle D., and Charles W. Bert. "Unsymmetric free vibrations of orthotropic sandwich shells of revolution." AIAA Journal 5, no. 3 (1967): 413-417.*
5. *Jones, Robert M., and Harold S. Morgan. "Buckling and vibration of cross-ply laminated circular cylindrical shells." AIAA journal 13, no. 5 (1975): 664-671.*
6. *Aydogdu, Metin. "Buckling analysis of cross-ply laminated beams with general boundary conditions by Ritz method." Composites Science and Technology 66, no. 10 (2006): 1248-1255.*
7. *Petit, Audrey, Habib Eslami, and Yi Zhao. "Nonlinear Forced Vibrations of Unsymmetrically Laminated Plates under Cylindrical Bending." In 48th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, p. 2112. 2007.*
8. *Yuceoglu, U., and V. Ozerciyes. "Free vibrations of composite shallow circular cylindrical shell panels with a bonded single lap joint." In 19th AIAA Applied Aerodynamics Conference, p. 1532. 2001.*
9. *Przekop, Adam, Salim Azzouz, Xinyun Guo, Chuh Mei, and Lahcen Azrar. "Nonlinear Stiffness Estimation for Modal Finite Element Approach to Free Vibrations of Shallow Shells." In 45th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference, p. 1615. 2004.*
10. *Ewins, D. J. "Modal testing: theory, practice and application (mechanical engineering research studies: engineering dynamics series)." (2003).*